

THE ORIENTATION OF PLANE FIGURES AS A
FACTOR IN THEIR PERCEPTION BY
CHILDREN

BY
CHARLOTTE RICE

A DISSERTATION

SUBMITTED TO THE BOARD OF UNIVERSITY STUDIES OF THE JOHNS
HOPKINS UNIVERSITY IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF DOCTOR
OF PHILOSOPHY
1929

BALTIMORE
THE WILLIAMS & WILKINS COMPANY
1930



The Orientation of Plane Figures as a Factor in Their Perception by Children

CHARLOTTE RICE

HISTORICAL

IF ONE were to limit a review of the field of perception to material which concerns the specific problem in hand, i.e., the orientation of plane figures as a factor in their perception by young children, practically nothing would be cited except the following general statement made by Stern in describing the reaction of his own children to pictures:

It has often been observed that it seems to make little difference to small children whether a picture is put before them right way up or upside down. . . . The older the child, the less of this indifference to the position of the picture; and in any case it varies very much with individuals, for there are children in whom it has not been observed at all. (19)

He cites careful observations of this indifference in his own children at the ages of one year seven and one-half months and three years five months, and explains the recognition and production of pictures upside down by the supposition that the idea of form and the idea of position are two distinct psychic functions, the second of which is only developed by a somewhat slow process of learning. To this report may be added the proverbial surprise of parents upon discovering that a child's enjoyment and comprehension

of a picture is in no way altered by the position in which he sees it.

But such data merely serve to indicate the existence, without limiting the ages, of a period in the life of the child when the position of a picture in no way affects his attitude toward it, followed by a period in which the orientation, when normal, helps, and when abnormal, hinders the comprehension and appreciation of the material presented to vision. Such a limitation was the purpose of the experiment here presented.

The three fields of imitative drawing, of recognition of similar forms, and of color and form preference in perception encroach so closely upon this one, however, that a preliminary review of the work done in them will be of sufficient interest to be worth while. Also more general deductions concerning the development of visual perception in children are constantly being made in other connections, such as the conclusion by Oppenheim (18) that a child comes to associate visual impressions with the proper relations of the object in space only in the most gradual way, and that this difficulty together with a limited power of accurate observation is bound to make his reports of events unreliable. Cra-maussel (4), in evaluating reports from

children three to six and one-half years of age concerning what they see on a postage stamp, concludes that as age advances, the specific takes the place of the vague and general in the response, confusion gives place to well defined limits, and enumeration gives way first to description and then to analysis. Such generalizations reflect the obvious fact that the development of perception is a gradual process, without limiting the steps involved. For the latter we must turn to the more specific experimental work.

The responses in imitative drawing are peculiarly limited. Always the child tends to draw what he knows rather than what he sees. For spontaneous drawing this is quite satisfactory, because he is under no obligation to finish the picture he starts. But for imitative drawing, which is rarely attempted at early ages except under experimental conditions, this tendency and the child's ready suggestibility make it difficult for him to persist in the task until it is completed, and frequently failure to copy even simple forms may go with a considerable degree of creative ability in spontaneous drawing.

In 1911, Van Gennep (22) reported unrecognizable attempts on the part of his 5 year old daughter to copy outline drawings of simple objects and printed letters. The pictures, having more meaning to the child, were more like the copies than the letters, though the latter were simpler of execution.

Huth (11), in 1914, experimenting with 37 kindergarten pupils averaging four and one-half years of age, to see whether they were ready to receive instruction in writing, concluded that

children of this age show little ability to copy meaningless combinations of lines. Work of more recent date on a comparable group of subjects was done by Gates and Taylor (8) in 1923, and Hertzberg (10) in 1926, on methods of teaching beginners to write. In these studies it was found that the method of copying directly from the model was both harder to learn and less interesting to the child than any of the various methods of tracing used.

Another section of this field is that of mirror writing, an anomaly which had been associated up until about 1902 almost entirely with cases of mental disorder or paralysis affecting normal motor coördination. But in 1909, Stern (20) reported mirror drawing and writing as a natural phenomenon in young children especially in imitative drawing. When, according to Stern, at four years, children begin to outgrow scrawling and make real forms, there appears, at first, little perception of position. The frequent easy use of the left hand at this period is often accompanied by mirror writing, and the tendency to watch the progress of an older brother or sister from across the writing table, and to imitate the observed motions, is a very frequent source of the development of reversed writing and drawing. E. Sz. at five years, copied from his brother in this manner, using his left hand, and learned his letters so well that he could write anything that was spelled to him. Later, he began suddenly and apparently without external urging to form his letters in the normal positions and order, still using his left hand, and finally, just as spontaneously, and

before he had reached the age of seven, he shifted from the left to the right hand, still maintaining the normal position and order of the letters. Stern cites similar cases, reported by Ballet, Degallier, Kerschensteiner, Maurer and Albien.

Two instances of a strikingly similar nature occurred in the Child Institute of the Johns Hopkins University last year. In one case, both the right and left hand were used in drawing, and the motions in the left hand were nothing less than a right to left reversal of those in the right. In the other case, the right hand alone was used, but many of the letters were formed backwards. In neither case did the child see anything exceptional in his result. Indeed, many adults who have not been trained to care in writing and printing show reversals of this nature,—as a hasty survey of “no trespassing” signs in any rural section of the country will show.

In 1913, Paula Meyer (17), in various experiments, under different conditions, but all designed to show a comparison between the child and the adult in the ability to reproduce figures from memory, found a consistent tendency for a certain percentage of reversal and inversion. The children used in the experiments were seven years old or older, and they showed a 51 per cent tendency to neglect orientation, as against a 39 per cent tendency on the part of the adults.

On the abnormal side, Downey (6) describes a case in which mirror writing, persisting into adult life was associated with general motor disorientation, and Hornig (7) finds dislocations

in writing and drawing combined with speech defects in elementary school children. Other cases in which the phenomenon is found along with pathological conditions are described by Abt (1) and Laprade (16).

It is evident from the above that orientation of the figure or letter seems to mean very little to a child who is just beginning to imitate in his drawing and writing. Whether a similar condition occurs generally with reference to a child's comparison of objects with regard to their similarity or difference, will be brought out, it is hoped, by the present experiment.

In the field of recognition of similar forms, much seems to depend at the outset on the child's ability to comprehend the significance of the terms “like” and “different.” The results of an experiment by Jones (12) in 1925 seem to indicate that in general the judgment of difference develops sooner than that of similarity. In dealing with geometrical forms or familiar outline figures, the complication of language development is to a large extent removed, but the importance of the comprehension of these two terms remains.

In 1913, Koch (14) employing a simplified form of Gruenbaum's (9) method found that the performance scores for the recognition of like elements in two figures increase from 22 per cent perfect to 64 per cent perfect among the boys from the first grade to the eighth, and from 25 per cent perfect to 63 per cent perfect among the girls, about 60 per cent of this gain occurring during the first four grades. When the recognition and localization of the unlike figures is included, the

girls reach in each grade, only about two-thirds the ability of the boys. In 1920, von Kuenburg (15) extended this work to children between the ages of three years six months and six years six months. Her figures substantiate those of Koch to a large extent.

In 1913 and 1914, in experiments devised to demonstrate the relative preference for form or color in matching figures, Katz (13) and Descoudres (5), concluded that the perception of form develops later than that of color. But when Buehler (3) and von Kuenburg (15) altered the conditions of the problem to include the processes of building with blocks, or fitting covers on boxes, they found that the choice according to form was preferred.

In 1927, Tobie (21) concluded from a combination and revision of these experiments that up to the age of three years, eight months, there appears a phase of early development in which the reaction to form or color is dependent not on the central conditioning, but on the intensity and vividness of the factors themselves. Above this, the child is conditioned on constitutional grounds to prefer color, gradually shifting over to form preference at about five years.

In 1929, Brian and Goodenough (2), repeating and modifying the Descoudres experiment, found form preference at all times up to the age of eight years except between the ages of three and six years, when color gradually rose to a peak and subsided again.

From the above it is evident that the development of form perception is gradually beginning to appear significant about the age of five years. While none of the experimenters have defined

the term perception—many of them avoiding it completely—there seems to be a general consensus of opinion that it refers to a certain type of reaction to sensory stimuli distinguished by a more or less well developed ability to discriminate—perception and discrimination growing in a parallel course. It is in such a sense that the term will be used in the material here presented.

It was in the course of a test for the discriminatory recognition of the diamond among a number of similar and dissimilar geometrical figures that the unexpected fact was disclosed that the two oldest children of the group refused to accept as the same, two figures which were identical except for their orientation in place on the page—the long axis of one diamond being horizontal, and of the other being vertical. No such refusal, or even hesitation was noticed on the part of any other child in the group.

Since the two children in question were at the very top of the age range of the group, being five years and one month and five years and three months respectively, it was logical to surmise that they might well be on the lower limit of an age range in which the orientation of a figure entered as a positive factor in its recognition and hence in its perception. Further preliminary study on another kindergarten group the same year, in which the age range was nearly identical, led to corroboration of the previous data. The demand for a test which would determine the possible existence and limits of such an age range was obvious, and so was developed the final form of the experiment herein to be de-

scribed, as a test by which to determine, if possible, the age when a child either will, negatively, refuse to recognize "sameness" in two figures which are identical, but not in the same position on the page, or will, positively, indicate by some word or action that they would be the same if one or the other were turned part way around.

DESCRIPTION OF EXPERIMENT

A problem in visual perception is almost bound to encroach somewhat upon kinaesthetic perception, not only because of the eye movements accompanying most acts of observation, but also, in the matter of certain grosser movements of different parts of the body—noticeably the hands. The latter is especially true when the aim of the perception is later recognition or reproduction. For this reason it was decided to combine with the test of form perception 2 other types of test; one, a test of the development of motor control in handling a pencil, and the other a test presumably of the ability to combine motor control and perception in the copying of a simple line figure. By showing the relation between the degree of development of the perception of form and the ability to copy a figure on the one hand, and motor ability and the ability to copy a figure on the other, it was hoped incidentally to throw some light on the general question of the relative importance of training in perception and in motor control for the accurate pictorial representation of form.

The complete test consists of an array of 5 individual tests, 2 forms of the copying test, 2 of the perception test, and 1 of the motor control test,

which are given in two test periods two weeks apart in time. During the first test period the child is presented with 3 of the 5 tests, 2 of the copying tests and 1 of the perception tests. Two weeks later, during the second test period, the child is presented with the other 2 tests, the second perception test and the test of motor control. A detailed account of the form of the tests and the experimental procedure follows.

Copying Test: Drawing of Diamond from Visible Model

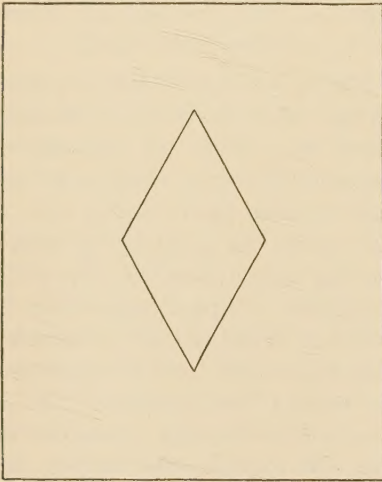
The materials for this test consist of a single white card 4 by 5 inches, on which is a black ink drawing of a diamond $2\frac{3}{4}$ inches (long axis) by $1\frac{1}{2}$ inches (short axis) (fig. 1, *a*). This card serves as a model in both the copying tests and in the tests of form perception. Slips of paper torn from pads 3 by 5 inches seem to furnish the most convenient form for maintaining the record of performance. The child is seated comfortably across the table from the experimenter and is shown the model card in the horizontal position with the instruction: "Do you see this (pointing to drawing, but being careful not to trace)? See what a nice picture you can draw for me that will look just like this." At the same time he is presented with a slip of paper, also in the horizontal position, and a pencil. Time is taken with a stop watch from the moment he begins to draw until the pencil is lifted after the last line. No matter what the result of the attempt, praise is given in the simple form "That's fine." When the child has finished, the experimenter takes the copy and

records on the same slip the time taken for the drawing. In cases where the production is a mere scribble, the time is taken between the beginning of drawing, and the first pause in operations or wandering of attention sufficient for the examiner to terminate matters with "That's fine" without appearing to interrupt an apparently well unified activity. This same procedure is then applied, with the model and paper both presented in the verti-

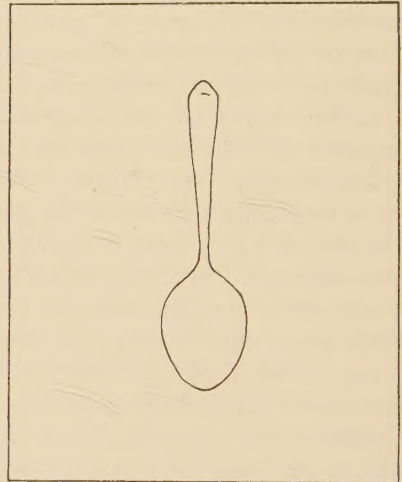
(pointing again to the model)." If the child says he can't, he is encouraged to try as hard as he can anyway by some such admonition as: "Oh, but everybody tries," or "But try just the best you can, anyway."

Test of Discriminative Perception: Perception of Diamonds—Vertical and Horizontal Presentation

The materials for this test consist of the model card described in the



a. Perception of Diamond Test



b. Perception of Spoon Test

FIG. 1. MODEL CARDS

cal position. Occasionally, if the second copy is better than the first, the form of praise is changed to "That's the best one yet." Frequently it is found that when the child starts to draw, especially in the cases of the younger ones, the lines suggest something other than the form he has been told to copy, and he announces that he will make you such-and-such a thing. The instructions are then repeated: "But make something that looks just as much like this as you can

copying test, and 4 cards $8\frac{1}{2}$ by 11 inches, each containing a variety of figures arranged as in figures 2 to 5 inclusive.

The diamond model is placed in front of the subject in the vertical position, and the following directions are given: "Now, I have a card here with some pictures on it, and one of them looks just like this (pointing to the model). I want you to see how quickly you can put your finger on a picture on this card (pointing to

the card) which looks just like this (pointing again to the model.)” Then while laying the first card in front of the subject—“Where is one that looks just like it?” The stop watch is started at the moment the card is placed in front of the subject, and is

points again, saying something such as “No, this.” In such a case, the fact is recorded but no change is made in the time. If an incorrect figure is pointed to without change, the record is made of the figure pointed to.

Before the second card is shown, the

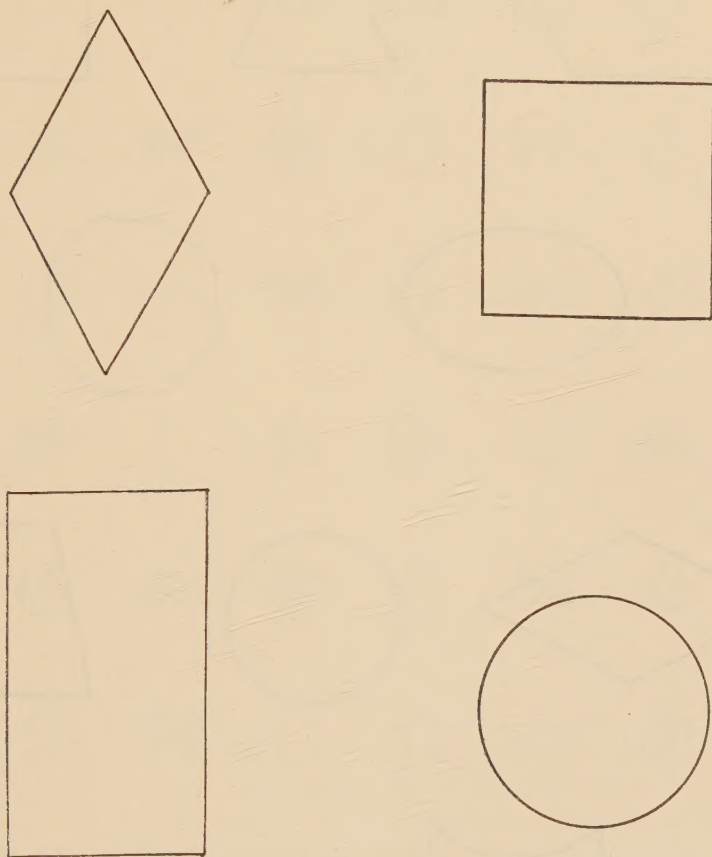


FIG. 2. PERCEPTION OF DIAMOND TEST—CARD 1

stopped the minute the finger comes to rest on the first figure indicated. No matter what figure is pointed to, the examiner's response is simply, “All right.” Occasionally, the child realizes immediately that the figure pointed to is not the correct one and

model is turned through an angle of 90 degrees, so that the diamond is shown in the horizontal position instead of the vertical, to coincide with the position of the diamond on the second card. This is done without comment, and in the least noticeable

manner possible. Then the second card is shown, with the directions, "I have another card here with some this (pointing again to the model and taking care that the child's attention is directed to it before the card is

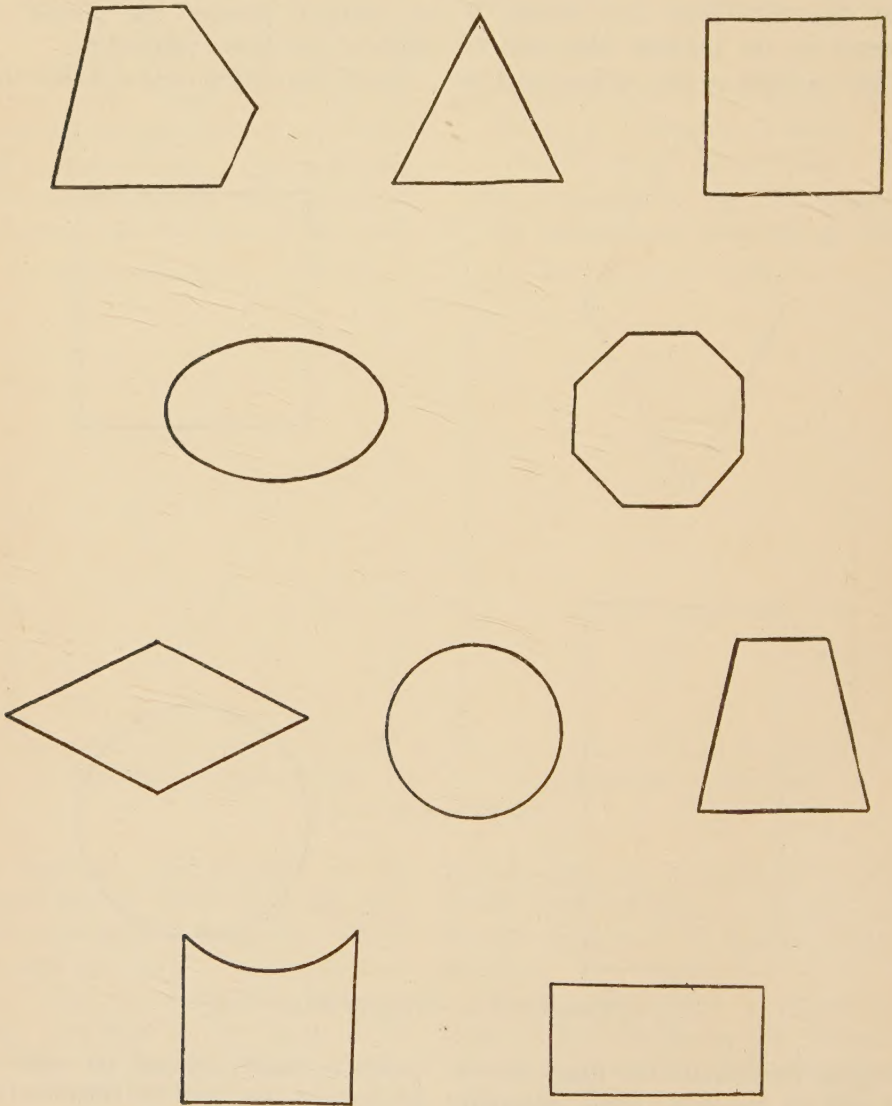


FIG. 3. PERCEPTION OF DIAMOND TEST—CARD 2

pictures on it. See how quickly you can find a picture on this card (pointing to the card) which looks just like shown).)" It is found imperative to exercise great care in giving the directions for the second card so that the



FIG. 4. PERCEPTION OF DIAMOND TEST—CARD 3



FIG. 5. PERCEPTION OF DIAMOND TEST—CARD 4

inflection of the voice on the final "this" should not betray by a rising inflection that the model was in any way different in form or position from the model as used for the first card. As in the first case, no matter what the response of the child, the experimenter accepts it with the assurance "All right."

Before the third card is shown, *no* change is made in the position of the model. In spite of the fact that the diamonds on the third card are in the vertical position, the model is left in the horizontal. The directions here are the same as for the second card, care being again exercised that the child's attention is drawn to the model before the card is shown, and that the experimenter's voice shall give no hint of the fact that there is any discrepancy between the position of the model and the diamonds on the card. If the child states that there is no figure on the card like the model, or if at the end of 45 seconds he has made no response but shows by his actions he is still searching, the model is turned into the vertical position by the experimenter with the question "Now can you find one?" Whatever the response of the child, the experimenter's response remains unchanged, "All right." Finally, with the model still in the horizontal position, the fourth card—which differs from the third only in the fact that half of the diamonds have been turned through an angle of 90 degrees—is shown with the same directions and the same care for details. Again, whatever the response of the child to the card, the experimenter accepts it as in the case of the others. On the fourth card,

after the initial choice, the child is asked to point to all the figures he can find which are just like the model. No time is taken for this, and the purpose of the request is to determine whether the child is choosing one position consistently, or is pointing merely to the first one in either position which looks to him like the model.

A record is made of the time and correctness of each response, together with a memorandum of the figures substituted in incorrect responses, and a detailed account of the responses in work or action to the third and fourth cards.

*Copying Test: Drawing of Diamond
from Memory of Model*

The material for this test is the same as that for the first copying test. The child is shown the model in the horizontal position for 10 seconds, and while he is looking, the following directions are given by the experimenter: "I want you to keep looking at this until I take it away. Soon I'm going to take it away and hide it, and then I want you to draw me a picture that looks just like it." If the child's attention tends to wander from the model while the experimenter is talking, the admonition is given to keep looking at the picture all the while. At the end of 10 seconds the model is taken away and turned over on the table, face down, while the experimenter says, "Now, I'm going to take it away and hide it, like this." Then, while placing before the child a slip of paper in the horizontal position, and giving him a pencil, the experimenter says, "Now, see what a nice picture you can draw me that looks just like

the one you have been looking at." If the child insists that he can't, he is urged to "Try anyway." No matter

peated, with the model and the paper in the vertical position instead of the horizontal.

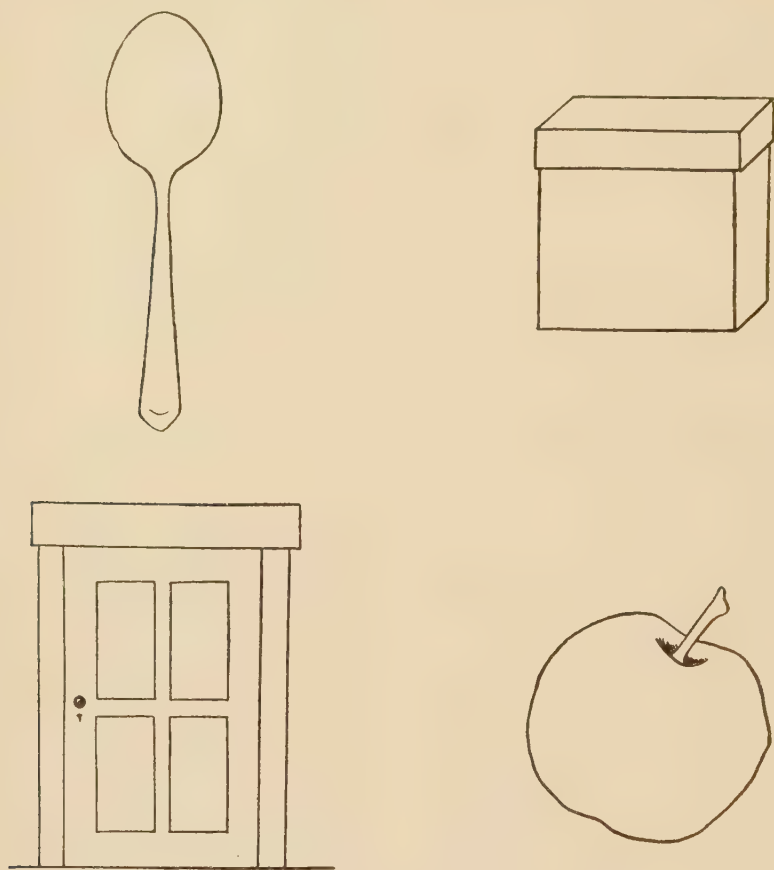


FIG. 6. PERCEPTION OF SPOON TEST—CARD 1

what the result of the attempt, praise is given in the simple form, "That's fine." Occasionally during this test, a child questions the examiner as to which position of the diamond should be drawn. In each case a non-committal answer is given such as "Draw it just as you saw it on the card." The record is taken of the time for drawing. Then the experiment is re-

Test of Discriminative Perception: Perception of Spoons—Vertical and Horizontal Position

The second discriminative choice test was devised with the idea in mind that a child's response to the test might be materially altered by the degree of familiarity of the objects figured. The model in this test con-

sists of a spoon drawn to the same scale (approximately) as the model diamond (fig. 1b). The figures on the cards, instead of being geometrical

for this test are exactly the same as those for the test of discriminative perception in which the diamond served as the model.



FIG. 7. PERCEPTION OF SPOON TEST—CARD 2

forms are of objects more or less familiar in the life of the child, as may be seen in figures 6 to 9 inclusive. The directions, procedure, and record taken

*Motor Test: Drawing Straight Line
Between Two Dots*

The materials for this test consist of a pencil and 4 slips of paper about

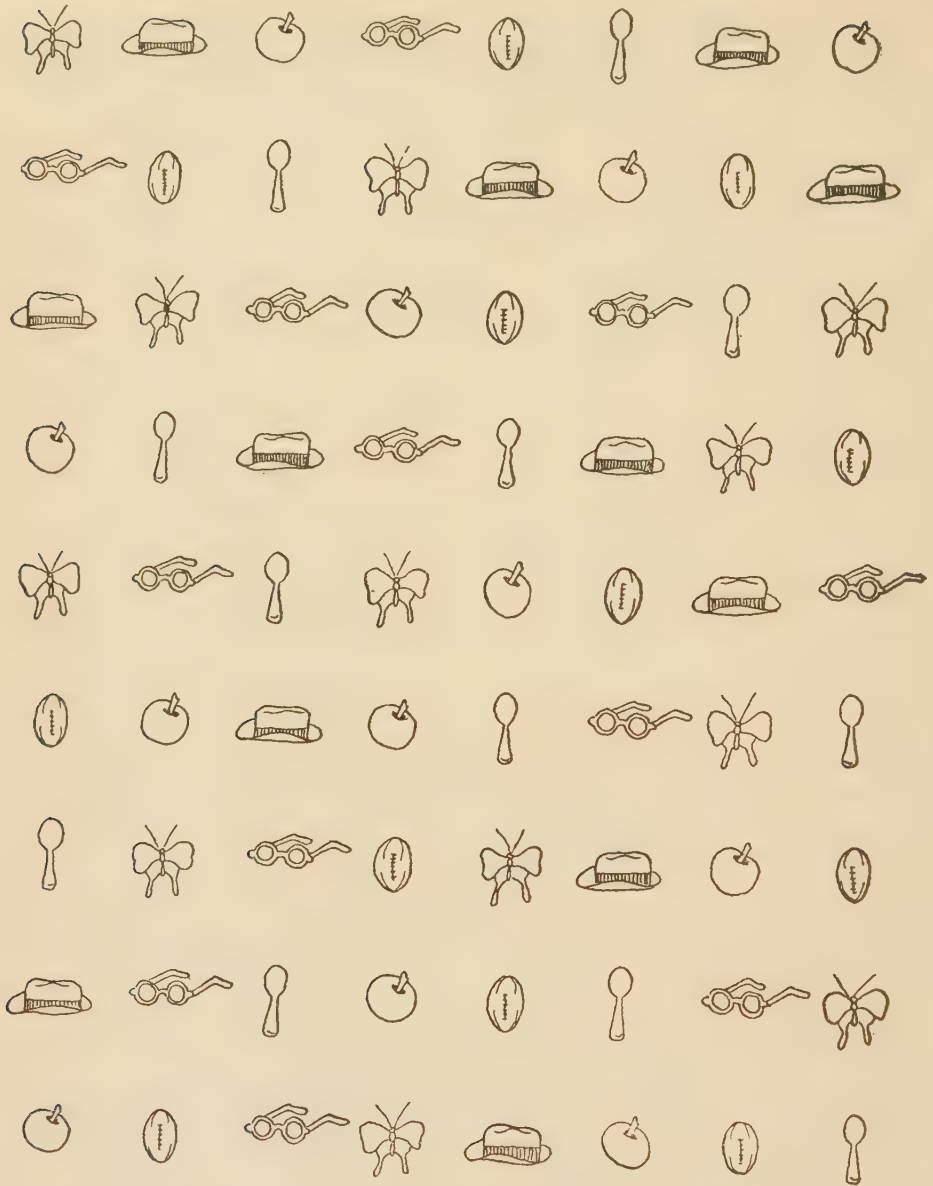


FIG. 8. PERCEPTION OF SPOON TEST—CARD 3

$4\frac{1}{2}$ by $5\frac{1}{2}$ inches, on each of which are 2 dots 75 mm. apart. On the first and third slips, the dots lie in a line slanting 30 degrees to the left of the vertical and 60 degrees above the horizontal.

On the second and fourth slips, the dots lie in a line slanting 30 degrees to the right of the vertical and 60 degrees above the horizontal.

The child is presented with a pencil

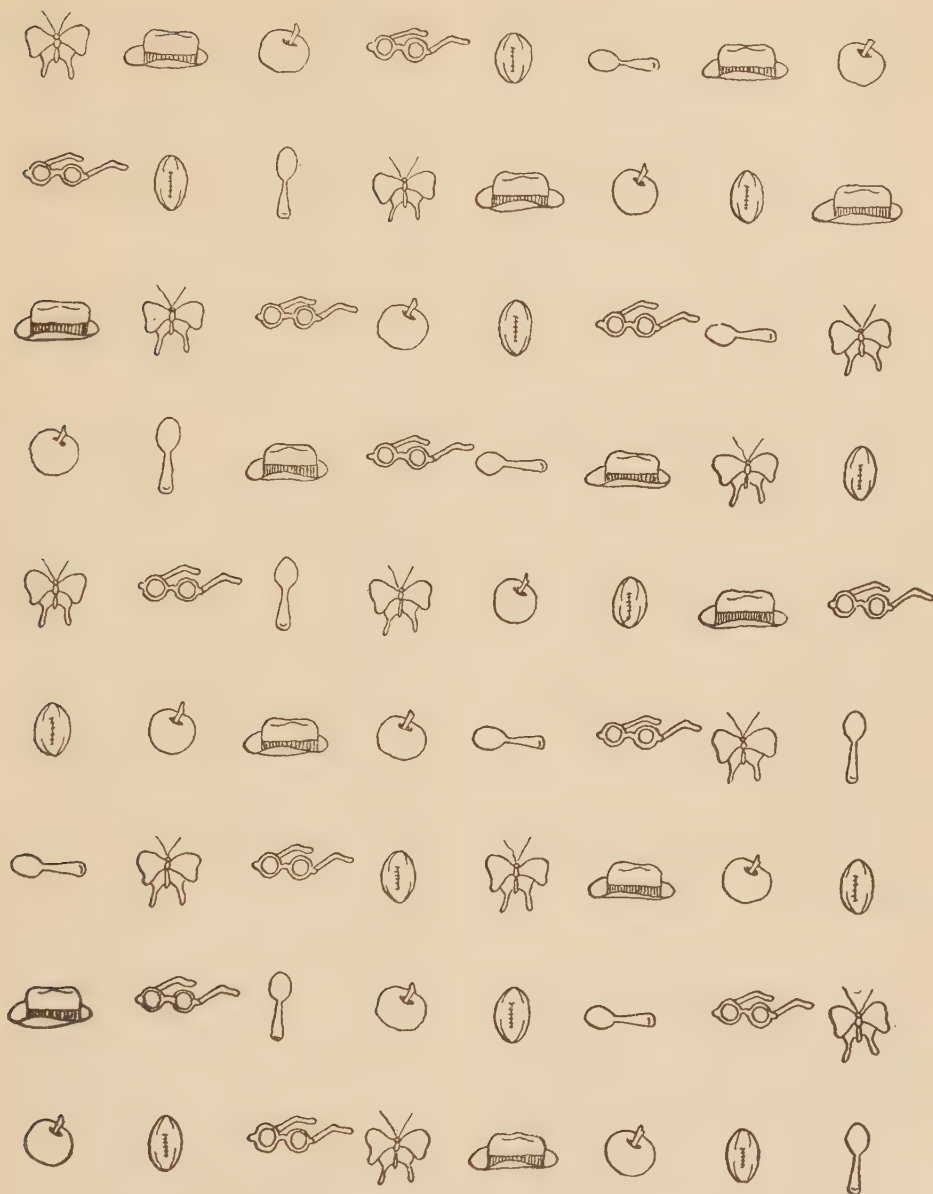


FIG. 9. PERCEPTION OF SPOON TEST—CARD 4

and the first slip with the directions:
 "See these two dots? I want you to
 see what a nice straight line you can
 draw me from this dot here (pointing

to the dot nearest the child) to this
 dot here (pointing to the dot nearest
 the experimenter). Begin here (point-
 ing again to the dot nearest the child)."

This last instruction checks a frequent tendency to begin drawing at the dot nearest the experimenter.

Time is taken from the moment the child begins to draw until he takes his pencil from the paper. An arrow is used to indicate the direction in which the line is drawn, and the paper is numbered 1, so that any failure to carry out directions may be checked in the analysis.

Three more slips of paper are given, numbered 2, 3, and 4 respectively, for which the directions, procedure, and record are the same except for the fact that the lines are to be drawn in different directions. On the second slip, with its 2 dots in a direction 30 degrees slant to the right of the vertical, and 60 degrees above the horizontal, the line is to be drawn from the one nearest the child to the one nearest the experimenter, as in the first slip. The third slip is like the first in form, and the fourth slip is like the second, but in both cases, the lines are to be drawn from the dot nearest the experimenter to the dot nearest the child.

SUBJECTS

The subjects for the experiment consisted of 226 children between the ages of two years, seven months and nine years, three months secured from the Child Institutes at the Johns Hopkins University and the University of Minnesota, and the kindergartens and first and second grades of two private schools in Baltimore, Maryland. A survey of occupational group and social class was unavailable, but in general the children came from homes of better class business and professional men.

Mental ages were available for only 138 of the group, and so could not be used in the evaluation of the data. But the I. Q.'s for those for whom the figures were available ranged from 78 to 158, with 15 cases below 100, and 15 cases above 130, a median of 115.5 and a mode of 116.

The subjects may be first divided into 4 groups according to the type of data which could be collected for them. The standard group (S), of 132 children, is composed of those for whom a complete set of data is available, and for whom the second test period followed exactly two weeks after the first. For the delayed group (D) of 23 children, a complete set of data is available also, but for this group, the second test period was delayed anywhere from 1 to 10 days beyond the two week interval. The incomplete group (I) of 36 children presents data for the first test period only. Finally, a preliminary group (P) of 35 children presents data only for the first discriminatory perception test, and these data are in such form as to be comparable but not identical with the data furnished in this test by the other subjects. Though the procedure was the same, only 3 of the 4 cards were used, and the scoring, done on the basis of 3 responses, and any notes on the behavior of the child, allowed a considerable amount of error to enter into the score given.

In general the unit of age employed was six months. From table 1 it will be seen that the greatest concentration and most even distribution of cases fall in the age groups from four years to eight years, which period, under the conditions of the experiment contains

the critical point in the age scale. Below and above this period other factors enter to a large extent to confuse the data. The justification of the inclusion of these cases in certain uses of the material will be evident later.

TABLE 1

Age distributions according to subject groups

AGES	S	D	S + D	I	S + D + I	P	S + D + I + P
2:1-2:6	0	0	0	0	0	4	4
2:7-3:0	3	0	3	0	3	5	8
3:1-3:6	7	3	10	0	10	6	16
3:7-4:0	3	0	3	0	3	6	9
4:1-4:6	8	2	10	3	13	5	18
4:7-5:0	9	4	13	5	18	8	26
5:1-5:6	11	2	13	4	17	1	18
5:7-6:0	7	1	8	9	17	0	17
6:1-6:6	21	4	25	0	25	0	25
6:7-7:0	18	6	24	3	27	0	27
7:1-7:6	19	0	19	8	27	0	27
7:7-8:0	19	0	19	4	23	0	23
8:1 and above	7	1	8	0	8	0	8
Total...	132	23	155	36	191	35	226

TREATMENT OF DATA

With the material gathered and carefully recorded, the next step consists in devising methods of scoring by which it may be evaluated and compared.

The diamonds are scored according to their excellency of form. A score of 1 is given when no attempt to make a copy is evident,—the usual response of children too young to understand the problem. A curved line enclosing a space is given a score of 2 points, and a score of 3 follows a reproduction of certain distinct characteristics of the

figure, such as straight line boundaries and angles. An inferior diamond with 4 sides and 4 angles and a semblance of symmetry is given a score of 4, while a score of 5 follows good proportion and correct orientation (fig. 10).

The child's score for the diamond copying experiment is determined from the scores for the 4 separate diamonds as follows: (a) If three or four of the 4 scores are the same, the summation score is taken as the same as the identical scores. (b) If the scores are divided 2 and 2, the higher number is taken as the summation score. (c) If 2 of the scores fall on 1 number, and the other scores are both odd, the summation score is considered as the mean, calculated to the nearest whole number. In every case under this category the estimated score falls on one of the numbers included in the individual scores. These scores, though rough, are comparable to the more or less rough scores of the other tests. Over two-thirds of the scores fall under category *a* above, and another scant fifth fall under *b*, so that in general these scores are quite representative of the ability of the subjects. A further use of the diamond copying scores is made by calculating a summation score for the scores obtained when the copying was done with the model in sight, and one for the scores obtained from memory.

On the perception tests a score of 0 is given for total failure on all 4 cards, a score of 1 if one form is discriminated, of 2 if two are discriminated, and of 3 if three are discriminated. A score of 4 is given for a correct discrimination of form regardless of its orientation on all 4 cards, and a score

of 5 is given for a correct discrimination of form on all 4 cards, with an indication of the difference in orientation on 1 of the last 2 cards. (It is interesting to note that in no case during the entire experiment was there a discrimination *against* the diamonds on card 4 which corresponded in posi-

copying and motor tests respectively, the first 4 scores were grouped as 2. 0 and 1 were grouped together as scores in which chance was the determining factor of choice, and 2 and 3 were grouped together as scores in which perception of similarities between forms was just beginning to appear.



FIG. 10. SAMPLES OF SCORINGS FOR DIAMOND COPYING TEST

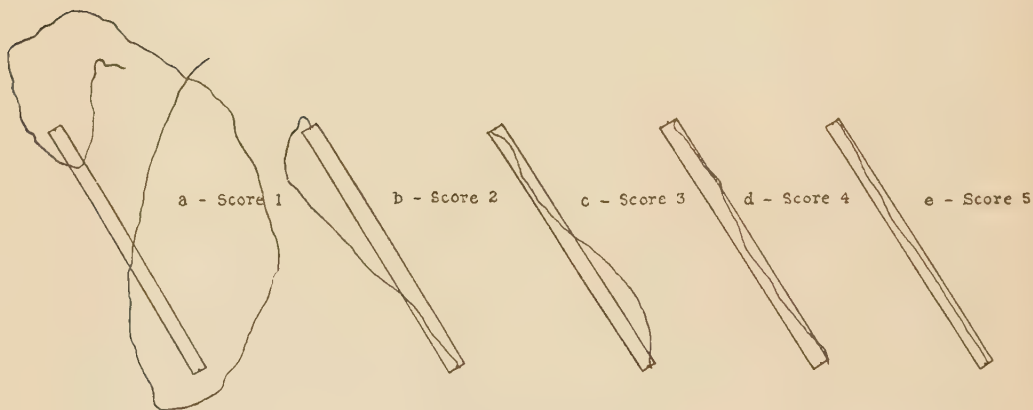


FIG. 11. SAMPLES OF SCORINGS FOR MOTOR TEST BY DETERMINING AMOUNT OF DISTANCE GOVERNED WITHIN 2 MM. RADIUS OF DIRECT PATH

tion to the model.) Finally, a score of 6 is given for a correct discrimination of form on all 4 cards, with an indication of the difference in orientation on both of the last 2 cards.

To make these scores comparable for correlation to the 5 scores of the

In scoring the performances of the children on the motor test a scale was constructed from transparent celluloid which could be superimposed on the line drawn and so oriented that on it could be roughly measured the amount of deviation of the line from the direct

path between the 2 dots. Both the motor test and the method of marking

study of the development of motor coördination in young children By

TABLE 2
Frequencies of scores for perception of diamonds

AGES	SCORES							TOTAL
	0	1	2	3	4	5	6	
2:1-2:6	4							4
2:7-3:0	5		2			1		8
3:1-3:6	4	3		2	5	2		16
3:7-4:0			2		5	2		9
4:1-4:6		2	2	1	12	1		18
4:7-5:0	1		1	2	17	2	3	26
5:1-5:6				1	10	1	6	18
5:7-6:0				1	10	3	3	17
6:1-6:6					9	3	13	25
6:7-7:0					8	4	15	27
7:1-7:6					1	3	23	27
7:7-8:0				1	1	5	16	23
8:1 and above					3	1	4	8
S + D + I + P.....								226

TABLE 4
Frequencies of scores for drawing of diamonds
—Combined scores for drawings from model, and drawings from memory

AGES	SCORES					TOTAL
	1	2	3	4	5	
2:7-3:0	3					3
3:1-3:6	2	7	1			10
3:7-4:0		2	1			3
4:1-4:6	1	2	7			10
4:7-5:0		3	10			13
5:1-5:6		2	7	4		13
5:7-6:0				8		8
6:1-6:6			10	13	2	25
6:7-7:0			1	21	2	24
7:1-7:6			2	13	4	19
7:7-8:0			2	14	3	19
8:1 and above			2	4	2	8
S + D.....						155

TABLE 3
Frequencies of scores for perception of spoons

AGES	SCORES							TOTAL
	0	1	2	3	4	5	6	
2:1-2:6								0
2:7-3:0	1			1	1			3
3:1-3:6	2				8			10
3:7-4:0					3			3
4:1-4:6					10			10
4:7-5:0					10		3	13
5:1-5:6					7		6	13
5:7-6:0					4		4	8
6:1-6:6					5	3	17	25
6:7-7:0					4	2	18	24
7:1-7:6					2	1	16	19
7:7-8:0					1	1	17	19
8:1 and above					1	1	6	8
S + D.....								155

TABLE 5
Frequencies of scores for motor test

AGES	SCORES					TOTAL
	1	2	3	4	5	
2:7-3:0	1	2				3
3:1-3:6	2	6	1	1		10
3:7-4:0			2	1		3
4:1-4:6	2		4	4		10
4:7-5:0			7	6		13
5:1-5:6			5	8		13
5:7-6:0			1	7		8
6:1-6:6		1	9	12	3	25
6:7-7:0			10	13	1	24
7:1-7:6			4	14	1	19
7:7-8:0			6	10	3	19
8:1 and above			1	6	1	8
S + D.....						155

it are modifications of the test used by Miss Wellman (23) at Iowa, in her

this scale, it may be determined what percentage of the distance between the

2 dots is covered within 2 mm. deviation from the direct course. A series of 5 scores is used. A score of 1 is given to a performance in which there is no attempt to fulfill the terms of the problem. A score of 2 is given to a performance in which less than 33 per

cent of the distance is covered within the 2 mm. radius (fig. 11). In determining a score for a particular child, the per cents for each of the 4 lines are added and the final score is calculated on the basis of one-

TABLE 6
Averages and ranges of time in seconds for responses in perception experiments

	DIAMOND TEST			SPOON TEST		
	Num- ber	Aver- age	Range	Num- ber	Aver- age	Range
Total.....	620	6.1	.2-45.0	620	4.6	.2-45.0
Correct.....	586	6.1	.2-45.0	607	4.7	.2-45.0
Incorrect.....	34	6.3	.4-44.0	13	2.2	1.0- 5.6
Card I:						
Total.....	155	1.8	.2-44.0	155	.9	.2- 7.0
Correct.....	149	1.4	.2-10.8	151	.9	.2- 7.0
Incorrect.....	6	10.1	.4-44.0	4	3.1	1.4- 5.6
Card II:						
Total.....	155	2.5	.4-20.2	155	1.0	.2- 7.2
Correct.....	143	2.3	.4-20.2	152	1.0	.2- 7.2
Incorrect.....	12	4.7	1.0-18.4	3	2.5	1.0- 5.0
Card III:						
Total.....	155	17.3	1.2-45.0	155	14.2	.8-45.0
Correct.....	147	17.9	1.2-45.0	152	14.2	.8-45.0
Incorrect.....	8	7.4	1.2-28.2	3	1.5	1.0- 2.0
Cor.—Orient. absent.....	80	6.2	1.2-40.4	63	4.5	.8-25.4
Cor.—Orient. present.....	67	31.8	4.4-45.0	89	21.5	1.0-45.0
Card IV:						
Total.....	155	2.9	.4-24.0	155	2.3	.4-28.0
Correct.....	147	2.8	.4-24.0	152	2.3	.4-28.0
Incorrect.....	8	4.7	2.6-14.0	3	1.7	1.0- 2.0
Cor.—Orient. absent.....	63	3.1	.4-24.0	60	2.4	.6-28.0
Cor.—Orient. present.....	84	2.6	.4- 8.9	92	2.2	.4-15.4

cent of the distance is covered within the 2 mm. radius. A score of 3 is given to a performance in which between 33 and 67 per cent of the distance is covered within the 2 mm. radius, and a score of 4 is given to a performance in which between 67 and 100 per cent of the distance is covered within the 2 mm. radius. Finally, a

fourth of the summation values thus obtained.

Such methods of scoring are rough, but the lack of standardization of the tests themselves would obviate finer treatment, and each test, as scored, indicates within itself, a consistent advance in performance ability from year to year (see tables 2, 3, 4, 5).

Experimentation in the handling of the data so as to give an accurate picture of what actually took place, demonstrated that, due to certain gaps in the data at the present time, a treatment of the data as actual frequencies rather than as per cents was much less confusing. For this reason, except in a few special cases which will be clearly stated, the actual frequencies are used as the working figures throughout the treatment of the data.

Time and correctness of response in the perception experiments

A tabulation of the time averages and ranges is given in table 6 for both the perception experiments. From this, the following facts are evident: (1) In all the responses exclusive of those to the third and fourth cards in which orientation is differentiated there is a gradual increase in time required for the response from card to card for the first 3 cards, due to the increased complexity of the task. This is not true for the fourth card which is enough like the third to make the effects of learning evident in the response. (2) The responses for the second experiment are shorter than those for the first, again probably showing the effects of learning. (3) The incorrect responses are longer for the same cards than the correct, with a few exceptions due to the low number of incorrect cases as compared with the correct. (4) Finally, the extreme increase in the reaction times for card 3 is apparently due to the weighting given by the responses in which orientation is differentiated. Such responses are lengthened by the fineness of the

differentiation required, and are frequently accompanied by hesitations and comments which show a recognition of the reversed position of the figure, and which indicate that the response is to 2 similar figures in different positions, rather than to 2 different figures. After the third reaction, the reaction to the fourth card becomes a relatively simple matter, as is indicated by the very much lower time average for this card than for the third. The third card, then requires the solution of a problem by the child, and the way the problem is solved seems to throw a good deal of light on the stage of development the perceptual life of the child has reached at the time of the experiment.

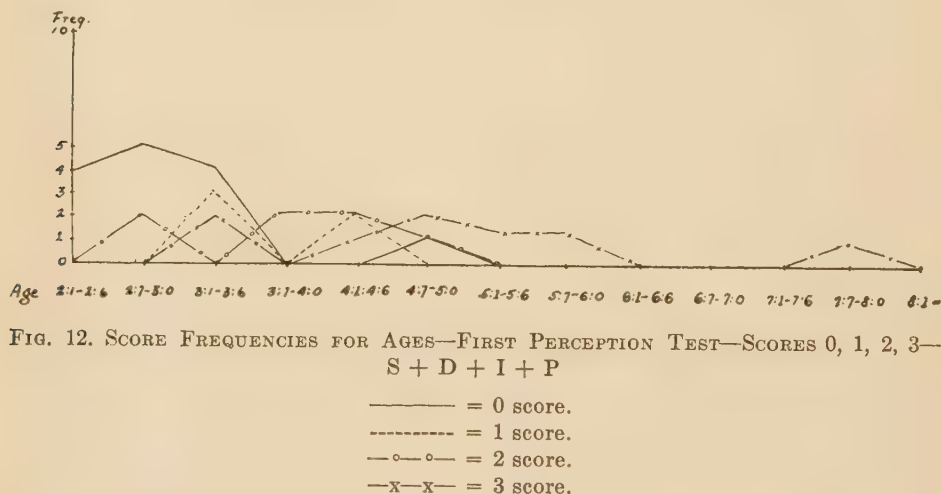
The factor of orientation as treated by the first perception experiment

The point of primary interest in the experiment is the analysis of the distribution of scores in the discriminatory perception tests, and of the bearing of the results on the question of orientation of figures as a factor in their perception. For this analysis, the material in the S, D, I, and P groups is used, for though the data in the last group have been collected under slightly different conditions, the age range of the group is such that, if its inclusion is justifiable at all, it will serve to add materially to the clearness of the frequency curves. It is felt that its inclusion is justifiable, moreover, because of the very slight change which occurs in the form of the frequency curves when these data are added. A study of the probabilities of curve fit showed that only in 1 age group does the figure drop below

.8, and in this particular case, the accumulated frequency of the S, D, and I groups is increased 200 per cent by the addition of the P data. Considering the small number of cases included, the probabilities are great enough to justify the addition of the data in the P group to those of the other three groups.

The curves of this distribution of score frequencies plotted from the data of table 2 are shown in figures 12 and 13. In figure 12, which shows the

other than the diamond. With one exception these occur below the age level of 3 years 4 months. The score of 1 has 4 possible forms. Of these, 3 occur, and within the 5 cases, 3 of the correct responses fall on the first card, and 1 each on the second and third. It is somewhat doubtful whether such responses indicate anything more than chance successes. The predominance of successes on the first card may indicate that the perceptual ability is there but that the child has not yet



curves for scores 0 to 3 inclusive, in spite of the still too scanty number of cases, the general tendency for each succeeding score to persist to a greater age than the one just below it is evident, showing a gradual development of perception from a stage of no recognition to one of fairly accurate discrimination. A closer inspection of the various kinds of responses for which these scores stand is interesting in this connection. The 0 scores, obviously, are those in which all 4 responses (3 in the case of the P data) are to figures

developed a sufficient degree of concentration to carry the problem in mind without distraction through the 4 responses. At least it rather obviates the possibility that the main cause for error is a lack of understanding by the subject of the problem in hand. The elements of chance success and lack of concentration seem to carry over into the 2 score. Here, in the total of 7 cases, 3 made correct responses to the first and third cards, 2 to the first and second cards and 1 each to the second and third and to the third and

fourth cards. For the score of 3 less variation is shown than would seem probable. Six of the 8 cases indicate correct responses for the first, third and fourth cards, and the other two for the second, third and fourth cards. The predominance of errors on the second card, and the form those errors take indicates that the low score is

a lack of appreciation of the problem to which the response is to be made.

A further analysis of the types of errors made in scores 0, 1, and 2 indicates an interesting course of development in discrimination. Of the 46 possible responses included in the 0 scores, 1 response was wholly negative, 10 consisted in pointing to each figure

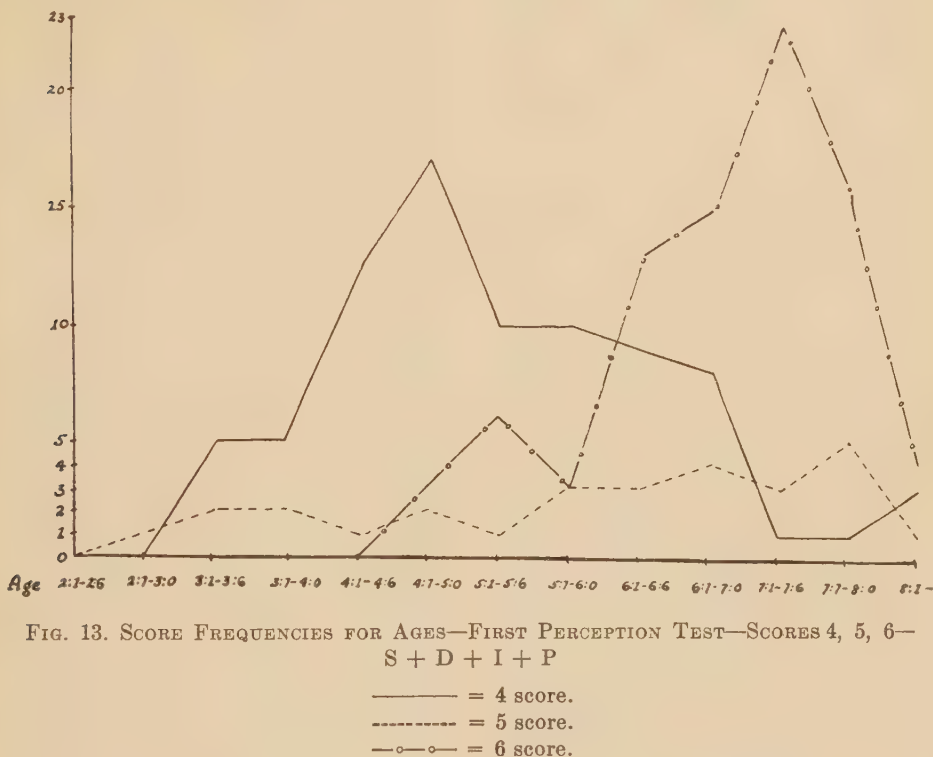


FIG. 13. SCORE FREQUENCIES FOR AGES—FIRST PERCEPTION TEST—SCORES 4, 5, 6—
S + D + I + P

— = 4 score.
 - - - = 5 score.
 ○ - ○ = 6 score.

caused mainly by the fact that the child has not yet reached the age of critical discrimination of form. Four of the 6 errors on the second card consist in responses to triangles, and the other 2 in responses to a truncated triangle and a rectangle respectively—all forms very similar to the diamond. The 2 errors on the first card consist in responses to the circles, and may indicate

on the card in turn, 27 consisted in pointing to a circular figure (the circle on the first 2 cards and either the ellipse or the wheel on the last), 3 to a rectangle, and one each to a curved-topped quadrilateral, a star, a hexagon, a pyramid of three bricks, and an irregular quadrilateral. The great predominance of responses to the circular figures is interesting in connection with

the general contention that circles are the first recognizable drawings made by children, and probably the first plane figures recognized by them. The response of pointing to each figure on the card in turn is also indicative of a very early stage of the response and does not occur except in the 0 score group. Among the cases scoring 1 point the responses to circular figures still appear as the most frequent errors, and comprise 4 of the 13 possible responses. After this, stars and rectangles occur twice each, and there are single responses each to the triangle, curved-topped quadrilateral, irregular quadrilateral, pyramid of bricks and bow. Here we find an increase in the proportion of angular figures. Whether or not we can say that the child is choosing them because they are more like the diamond is doubtful. But at least we are approaching a broader field of recognition than that limited to the circular forms. This field broadens still farther in the cases in which 2 correct responses are given. Here, of the 9 instances of error only 3 are circular figures, while 2 are triangles, and single cases occur of the rectangle, curved-topped quadrilateral, pyramid of bricks, and bow. Though there is here a lack of any particular emphasis on the circular figures, the figures chosen, as a whole, do not yet bear any striking resemblance to the diamond, as is true in the errors recorded in connection with the scores of 3.

With this picture of the general perceptual development as a background, it is most interesting next to compare the curves for the next 4 scores, all of which stand for perfect

discrimination of the diamond, but with different qualitative factors included. In figure 13, which shows the curves for scores 4 to 6 inclusive, an exceedingly interesting period of development is displayed. Appearing as early as three years in a few scattering cases and rising rapidly to a climax between four and one-half and five years, the recognition of likeness between the 2 figures, regardless of their orientation on the sheet—as represented by a score of 4—begins to drop off in the face of the rising scores 5 and 6. Indeed, scores 4 and 6 show a very beautiful opposition representative of the antagonism of the 2 responses implied. For the recognition of likeness between 2 figures only when they are identically oriented—as represented by the score of 6—not only develops after the state represented by 4, but develops to its final exclusion. Score 5, on the other hand, representing an apparent state of doubt on the part of the child between scores 4 and 6, shows no peak between the peaks of these scores—a situation which might have been expected rather than the one shown. In fact, the distribution of score 5 as it appears in the curves raises a strong question whether the jump from a score of 4 to a score of 6 is not a sudden one, with no intermediate step, and whether the score here represented by 5 may not represent an even greater mental development than that represented by 6. On the face of it the drop of the curve of score 6 from a frequency of 23 at seven to seven and one-half years to a frequency of 16 at seven and one-half to eight years, and a coincident rise of score 5 from 3 to 5 during the same

time may be significant. Beyond eight years, the forms of the curves are not significant—a fact which was previously stated in the discussion of the choice of subjects. Whether the addition of more subjects in age ranges above these studied here would lead to a further drop in the curve of score 6 and a corresponding rise in the curve of score 5 will need further experimentation to determine. If, as Dunlap has stated, in developing perception we are at the same time developing thinking by laying in store elements later to be used in thinking, might not the state represented by score 5 be one in which a more comprehensive integration of perceptual elements had been utilized, i.e., a state in which simplicity of response had given place to a complexity of possible responses which made the final choice doubtful, hesitating, and perhaps we might say, more thoughtful than the rest. A closer analysis of the actual responses grouped under the score of 5 may throw some light on the matter.

The absence of card 4 from the P group obviates the use of these data in such an analysis, but among the total number of 191 cases included in groups S, D, and I, 24 received a score of 5 on the first perception experiment. Three of these 24 cases were instances in which the child responded to the third card negatively, in one case being unable to find a figure like the model until the model had been turned into the position of the diamonds on the card, and in the other 2, pointing to some of the diamonds on the card, but objecting to the fact that they were turned in the wrong direction. At the presentation of the fourth card, how-

ever, both positions of the diamond were pointed to without discrimination in all three cases. In the 2 cases which commented on the difference in orientation, each child seemed perfectly conscious of the factor, but seemed to be having difficulty in deciding whether the experimenter wanted the diamonds pointed out with reference to or in spite of it, and finally decided to do it in spite of the factor. The other case showed nothing by which such an interpretation could be made.

In the other 21 cases, the situation was reversed. Here the diamond on card 3 was pointed to with little or no hesitation and without any apparent consideration of orientation as a limiting factor. But upon the presentation of the fourth card on which diamonds appeared in both positions only those in the same position as the model were indicated. In no case was there any attempt on the part of the child at an explanation of what to an adult mind would be an ambiguous response. The child was apparently solving each situation as it came up. Either the lack of any diamonds on the first card to correspond exactly with the model led to the choice of the second best, and the presence of both kinds on the fourth card led to the choice of only those most exactly like the model, or else the presence of the 2 kinds on the fourth card called the child's attention to a factor which he had not noticed before, and served as a suggestion to him to treat the situation in a new way. If the latter is the case it may well be argued that the reaction receiving a score of 5 is a mere intermediate response between the reac-

tions represented by scores 4 and 6. If the former is the case the reaction would seem to be more that of indecision on the part of the child as to just what sort of a reaction is wanted. There is nothing within the experiment itself by which the possible attitude of the child can be discovered, or by which we are justified in assuming one explanation or the other for the occurrence of a reaction corresponding to score 5.

A tabulated comparison of the responses to cards 3 and 4 for all the 191 cases in groups S, D, and I show that 88 per cent of the responses are in agreement on the 2 cards, while only 2 per cent (those receiving score 5) are in disagreement. Of the 88 per cent in agreement, 5 per cent (including all individuals having scores of 0, 1, and 2) were consistently incorrect, 41 per cent (including all individuals having scores of 3 and 4) were consistently correct, but showed no sign of the recognition of differences in orientation, and 43 per cent (including all individuals having a score of 6) were consistently correct and cognizant of orientation as a factor in the perception of likeness in plane figures. The relatively small number of inconsistent responses would lead one to one of two conclusions, either that the stage of uncertainty, if existing, as was first thought, between types of responses represented by scores 4 and 6, is extremely transient, and is caught only very infrequently by such a test, or the inconsistent response is a more mature response than those represented by either score 4 or score 6, and so is only beginning to appear in the age range here covered. Careful de-

velopmental study of a considerable number of individual children over a number of years would indicate any bases for accepting or discarding the first conclusion, while an extension of the upper age limit on the present experiment would go far in justifying or eliminating the second. The status of the scoring in this experiment is as yet so much that of uncertainty that it is impossible to state arbitrarily, without this further study, that one of these three higher scores indicates a more mature response than another. We can merely point to the results of the experiment as indicative of a fairly clear state of affairs during the ages two and one-half to eight years, and leave the significance of the various responses, in the light of maturity of development to be determined after further experimentation at other age levels.

A comparison of the first and second perception experiments with a view to the part familiarity of the figure may play in the modification of the reaction to orientation

A comparison of the first and second perception experiments involves only the data from subject groups S and D. The justification of the use of the D data in the second perception test (which might be questioned because of the variability of the time between the 2 test periods for this group) is based on a comparison of the closeness of fit between the frequency curves for the 2 groups on the first test, and the closeness of fit between the curves for the 2 groups on the second test. In only one case does the difference between the closeness

of fit in the first experiment and the closeness of fit in the second exceed twice the value of sigma and become significant, and that particular instance is one in which the discrepancy lies obviously in the low value of the probability in the first perception experiment.

In proceeding, then, to a comparison of the results obtained on the first perception test with those obtained on the second test, for the S and D groups—155 cases in all, it was assumed at the outset that the factor of familiarity of the figures might in some way affect the influence of the factor of orientation, and that if this influence were present, it would probably be on the side of lessening or even eliminating the effect of orientation, so that the child would pay no attention to the position of the figure in his choice. Here ease of recognition would increase the likelihood that slight differences of detail would be overlooked. A general correlation between the scores on the two tests irrespective of age gives $.66 \pm .032$. This correlation, in the absence of other tests of the same factor to which this test may be compared, shows a good reliability of the test within itself. It also seems to indicate that though there may be some factor entering in the second test which was not present in the first, to keep the correlation from being higher, whatever that factor is, it does not have any tremendous effect one way or the other. A close analysis of the changes in score from one test to the other will be interesting in this connection. If the factor is the one of familiarity mentioned above, one would expect to find a good majority

of losses in score over gains, especially among the scores 4, 5, and 6. As a matter of fact, in the 45 cases in which a change in score occurs between the first experiment and the second, there are 36 cases in which the score is raised and only 9 cases in which the score is lowered. Each of these 9 cases, moreover, represents only a single point's loss, one being a drop from a score of 1 to a score of 0, 7 being drops from scores of 5 to scores of 4, and 1 being a drop from a score of 6

TABLE 7

Detailed table of gains and losses in score for whole group,—from diamond perception test to spoon perception test

LOSSES				GAINS			
Score		Frequency	Per cent of total	Score		Frequency	Per cent of total
From	To			From	To		
1	0	1	11	0	3	1	03
5	4	7	78	0	4	2	05½
6	5	1	11	1	4	2	05½
				2	4	1	03
				3	4	5	14
				3	6	1	03
				4	5	3	08
				4	6	11	30
				5	6	10	28

to a score of 5. The gains, on the other hand, not only predominate four to one in number, but range in magnitude from one to four points and total 62 of the 71 total points of change recorded between the 2 experiments. A detailed table of the gains and losses will be found in table 7. It is fairly certain from this that familiarity with the figure, if it does serve as a limiting factor, does not tend to overshadow the factor of orientation. If anything, it tends to sharpen it, though

the tendency to increase in score is probably not sufficient to warrant the assumption of any factor other than the mere greater familiarity with the procedure which the child experiences at the second test period.

The probability that greater familiarity with the procedure of the second test is the determining factor in changes in score between the two tests is heightened by an inspection of table 9. From this it is evident that 28 of the 45 changes—both gains and losses—are from one of the doubtful scores, 0, 1, 2, 3, or 5 to one of the positive scores, 4 and 6, and 11 of the gains are from score 4 to score 6, i.e., from one positive score to another more advanced. Thirty-nine, then, of the 45 changes are toward greater certainty. Two, one loss in score from 1 to 0, and one gain in score from 0 to 3, are from hesitation to hesitation in nature, and only 4, one loss in score from 6 to 5, and three gains in score from 4 to 5 show a change from positiveness to hesitation. In general, then, on the second test the children were much surer of what they were going to do, and probably the correlation between the 2 tests is as low as it is, merely because of the greater familiarity of the children with the experimental procedure at the second test period, and not because of the interference of a factor of familiarity of the figure with the factor of orientation. This point could be assured by reversal of the order in which the 2 perception tests are presented to the children.

A further analysis of the distribution of the changes in score shows that they are fairly evenly distributed over the

age range. Twenty cases of change occur in the first 3 years of the age scale, from two years seven months to five years six months, and 25 cases occur in the last 3½ years, from five years seven months to nine years three months. Of the 20 cases of change in the first half, 15 are cases of gain and 5 are cases of loss, while of the 25 cases of change in the second half, 21 are cases of gain and 4 are cases of loss. Among the gains, those of the greatest magnitude are confined to the earlier 3 years. In this group are 100 per cent of the gains of 4 points and 3 points, 25 per cent of the gains of 2 points and 33 per cent of the gains of 1 point, and the other 75 per cent of the gains of 2 points and 67 per cent of the gains of 1 point comprise the total number of gains in the last three and one-half years.

Generally speaking, though the gains and losses are fairly well distributed over the age scale, the gains for the first three years average much larger than those for the last three and one-half years. This fact in itself would tend to lower the correlation between the 2 tests, and further emphasizes the fact that it is probably the greater familiarity with the procedure of the second test which accounts for any differences between the 2 performances.

Comparison of the tests of discriminative perception with the related tests of copying and motor control

It remains now to show what bearing performance on these tests of discriminative perception has on the ability of a child to copy a given figure, and to compare the relative

parts perception and motor ability play in such copying. For this only S and D data are used.

Because of incomparable scaling of the perception tests as compared with the better standardized scores on the other two tests correlations are of

TABLE 8

Frequencies of scores for perception of diamonds as compared with scores for copying diamonds

PERCEPTION OF DIAMOND —SCORES	DIAMOND COPYING TEST—SCORES				
	1	2	3	4	5
6			13	45	8
5		1	5	9	5
4	1	9	21	22	1
3		3	3		
2		1	1		
1	2	1			
0	3	1			

TABLE 9

Frequencies of scores for perception of spoons as compared with scores for copying diamonds

PERCEPTION OF SPOON— SCORES	DIAMOND COPYING TEST—SCORES				
	1	2	3	4	5
6			18	56	12
5			1	6	
4	4	12	26	15	1
3	1				
2					
1					
0	1	2			

little significance except to indicate the possible validity of the scoring of the perception tests themselves. A better comparative picture of the responses given on the respective tests is gained from tables 8, 9, 10, 11 and 12.

While the table giving the scores

of the diamond copying test as compared with the motor test scores

TABLE 10

Frequencies of scores for perception of diamonds as compared with scores for motor test

PERCEPTION OF DIAMOND —SCORES	MOTOR TEST—SCORES				
	1	2	3	4	5
6			19	42	5
5	1		7	11	1
4		3	23	26	2
3		1	1	4	
2	1	1			
1	2	1			
0	1	3			

TABLE 11

Frequencies of scores for perception of spoons as compared with scores for motor test

PERCEPTION OF SPOON— SCORES	MOTOR TEST—SCORES				
	1	2	3	4	5
6			28	53	6
5			3	3	1
4	4	6	19	27	1
3		1			
2					
1					
0	1	2			

TABLE 12

Frequencies of scores for diamond copying test as compared with scores for motor test

MOTOR TEST— SCORES	DIAMOND COPYING TEST—SCORES				
	1	2	3	4	5
5			2	5	1
4		5	20	47	11
3		5	19	25	1
2	4	4	1		
1	2	2	1		

shows an even progression between the 2 tests, the tables giving the score

frequencies for the perception tests and the others show the difficulty which arises in trying to get an even progression between two tests graded in such a manner that one presents a unimodal curve of frequency and the other a bimodal, and that while one is scaled high enough so that there is a drop in frequency at the end of the curve, the other is not. In spite of this, however, there is indicated a more or less parallel progression of the two sets of scores in each case. This

the diamond tests in comparison with the substantial correlations between the first perception experiment and the diamond tests. This phenomenon is explainable first on the grounds that the first perception experiment and the diamond tests were done on the same day, while the second perception test was performed two weeks later, and second, by the factors of learning and greater familiarity with the procedure experienced in the second test period. The scores on the first

TABLE 13

PERCEPTION OF	DRAWINGS OF	<i>r</i>	PE <i>r</i>	Pr
Diamonds :	All diamonds.....	.35	.032	.0000006
Spoons :	All diamonds.....	.01	.05	.865
Diamonds :	Diamond from model.....	.37	.047	.00000022
Spoons :	Diamond from model.....	.16	.05	.0424
Diamonds :	Diamond from memory.....	.46	.05	Negligible
Spoons :	Diamond from memory.....	.25	.05	.000938

TABLE 14

FACTORS INVOLVED	<i>r</i>	PE <i>r</i>	Pr
All diamonds : Motor Test.....	.18	.05	.0208
Memory diamond : Motor Test.....	.25	.05	.000938
Visible diamond : Motor Test.....	.25	.05	.000938

is more true of the tables comparing the scores of the first perception experiment with the other tests than of those comparing the second perception experiment with the same tests—a fact which bears out still further the contention of a difference between the factors involved in the two perception tests.

The correlations serve to show some interesting tendencies (see table 13). The first thing of note in these figures is the lowness of the correlations between the second perception experiment and

perception test are undoubtedly a more accurate estimate of the general state of the child's perceptive ability along the lines indicated than scores on the second perception test, and for this reason the fairly high correlations between this test and the diamond test are of vast interest in indicating a parallel development of perception and ability to copy figures.

The second point of interest in the above figures lies in the fact that the highest correlation is between the perception of diamonds and the dia-

mond drawn from memory. The factor of holding a memory image of the figure long enough either to find it again or to reproduce it seems to bind these 2 tests together. The correlation between the memory diamond scores and the visible diamond scores is $.36 \pm .047$, and the fact that the correlations between the first perception test and the diamond copying test are as high as or higher than this correlation is an added point in favor of conceding some slight significance to the figures.

The correlations between the scores for the diamond copying tests and the scores for the motor tests are shown in table 14. They are positive, but less significant, a fact doubly interesting because these correlations are between 2 relatively well standardized tests.

Finally, the correlation between the scores on the motor test and the scores on the first perception test is found to be $.68 \pm .03$. This is the highest correlation to be found in the whole group, and is interesting in view of the axiom derived from the response hypothesis that accuracy of motor response is a basis for accuracy of perception and later of thought. It may be that precocity in general motor development is paralleled by a corresponding precocity in the development of perception, and that the reason the correlation between the motor test and the diamond drawing tests is not greater lies in the greater complexity of the factors involved in the diamond drawing tests which are as yet unanalyzed and confuse the issue.

The probability of entrance of ex-

traneous factors into the second perception test is strikingly substantiated, in the view of the last paragraph by the fact that the correlation between this test and the motor test is $-.17 \pm .05$.

To return to the nature of the response scored as 5 on the perception experiments in the light of this discussion—if score 5 is in reality a superior score to score 6, we would expect to find that the motor scores for children receiving scores of 5 on the first perception experiment would be relatively higher than those for the other children. But, in 10 of the 20 cases in which these data are available, the scores on the motor test fall exactly on the modes of the score frequency curves for the particular ages, in 7 cases they fall 1 point below the mode, and in 3 cases they fall 1 point above. Very little conclusive evidence is to be obtained from this survey, and what may be obtained rather disavows any superiority in the children scoring 5 on the first perception test.

CONCLUSIONS

Summarizing, it must be said that the results are on the whole indicative rather than conclusive. The subjects are too few, and there is too little material with which to compare the results of the tests, to give the interpretations herein presented other than a tentative aspect. A few points, however, are clearly brought out as follows:

1. Orientation on the page, of plane figures, appears to rise rather suddenly as a factor in their perception between the ages of 5 and 6 years—or between the standard kindergarten age and the

standard first grade age. The break is apparently rather sudden for the individual child with little or no transition; and for the group, it may be located much more exactly than one might expect.

2. In the work here outlined, the degree of familiarity with the figures used in the perception tests seems to bear little or no relation to the reaction toward the orientation of the figures on the part of the child. Any relation which may exist, is in this case obscured by the effect of greater familiarity with the test procedure at the second test period.

3. The first perception test may be taken as a truer measure of the child's general perceptual development along the lines indicated than the second perception test, because of its greater

freedom from any factor approaching that of learning.

4. Perceptual development appears to be more closely allied than motor development with development in imitative drawing.

5. A very high correlation exists between scores on perception and scores on motor control. Just what this means is speculative, but it is highly probable that it is indicative of a very close interplay of the two factors in the course of the development of the child.

6. Aside from these general points, a specific field for further speculation and investigation lies in determining the significance of ambiguous performances and in determining the relation of the responses given at these ages with those of adults.

REFERENCES

- (1) ABT G.: Sur l'écriture en miroir. *L'Année Psychologique*, 1901, pp. 221-255.
- (2) BRIAN, CLARA R., and GOODENOUGH, FLORENCE L.: Color and form perception at various ages. *J. Ex. Psych.*, 1929, **12**, pp. 197-213.
- (3) BUEHLER, KARL: *Die Geistige Entwicklung des Kindes*. 4th Ed., 1924, p. 170.
- (4) CRAMAUSSEL, E.: Ce que voient des yeux d'enfant. *Journal de Psychol.*, 1924, **21**, pp. 161-170.
- (5) DESCLOUDRES, ALICE: Couleur, forme et nombre. *Arch. d. Psychol.*, 1914, **14**, pp. 305-341.
- (6) DOWNEY, JUNE: On reading and writing of mirror script. *Psych. Rev.*, 1914, **21**, pp. 408-441.
- (7) DOWNEY, JUNE: Abstract. *Psych. Bull.*, 1911, **8**, p. 315.
- (8) GATES, ARTHUR I, and TAYLOR, GRACE A.: The acquisition of motor control in writing by pre-school children. *Teach. Col. Rec.*, 1923, **24**, pp. 459-469.
- (9) GRUENBAUM: Ueber die Abstraktion der Gleichheit. Ein Beitrag zur Psychologie der Relation. *Arch. f. d. ges. Psychol.*, 1908, **12**, pp. 340-480.
- (10) HERTZBERG, OSCAR EDWARD: A comparative study of different methods used in teaching beginners to write. *Teach. Col. Contrib. to Educ.*, no 214, 1926.
- (11) HUTH, A: Form Auffassung und Schreibversuch in Kindergartenalter. *Zeitsch. f. paed. Psychol.*, 1914, **15**, pp. 566-629.
- (12) JONES, VERNON A.: A study of children's ability to note similarities and differences. *J. Ed. Psych.*, 1925, **16**, pp. 253-260.
- (13) KATZ, D.: Studien zur Kinderpsychologie. *Wissenschaftl. Beitr. zur Paed. u. Psychol.*, 4 Heft, 1913.

- (14) KOCH, A.: Experimentelle Untersuchungen ueber die Abstraktions-fahigkeit von Volksschulkinder. *Zeitsch. f. angew. Psychol.*, 1913, **7**, pp. 332-391.
- (15) KUENBURG, MARCELLINA GRAEFIN V.: Ueber Abstraktionsfahigkeit und die Entstehung von Relation beim vorschulpflichtigen Kinde. *Zeitsch. f. angew. Psychol.*, 1920, **17**, pp: 270-312.
- (16) LAPRADE: L'ecriture en miroir. Doctor's Thesis, 1902.
- (17) MEYER, PAULA: Ueber die Produktion eingepraegter Figuren unsw. *Zeitsch. f. Psychol.*, 1913, **64**, pp. 34-91.
- (18) OPPENHEIM, N.: The development of the child, p. 159.
- (19) STERN, W.: Psychology of early childhood, 1926, p. 190.
- (20) STERN, W.: Ueber verlagerte Raumformen. *Zeitsch. f. angew. Psychol. u. psych. Sammelforschung*, 1909, pp. 498-526.
- (21) TOBIE, HANS: Die Entwicklung der Beobachtung von Farbe und Form in Vorschulalter. *Zeitsch. f. angew. Psychol.*, Beiheft 38, 1927.
- (22) VAN GENNEP, A.: Dessins d'enfant et dessin prehistorique. *Arch. d. Psychol.*, 1911, **10**, pp. 327-337.
- (23) WELLMAN, BETH: The development of motor coördination in young children. *Univ. of Iowa Studies*, no. 108, 1926.

VITA

Charlotte Rice, daughter of Edward L. and Sarah L. Rice was born at Delaware, Ohio, January 10, 1904. She received her elementary and high school education in the public schools in Delaware, Ohio; her undergraduate education, at Ohio Wesleyan University, Delaware, Ohio, 1922-1926, receiving her A. B. degree in 1926; her graduate education in psychology at the Johns Hopkins University, 1926-1929, and at the University of Minnesota, summer of 1928. She has had experience as undergraduate laboratory assistant in psychology at Ohio Wesleyan University in 1923-1924, as graduate assistant in psychology at the Johns Hopkins University in 1927-1928, as assistant specialist in Nursery School, Kindergarten and Primary Education in the Bureau of Education at Washington, D. C., in May, June and July, 1927, and as mental tester for the Children's Aid Society of Baltimore County, and the Park School, Baltimore, Maryland, in 1927-1928. During 1928-1929 she was recipient of a National Scholarship for Research in Child Development from the Spelman Fund of New York.

